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Kotani

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(54) **POST-PROCESSING DEVICE HAVING SHIFTED SHEETS**

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B65H 31/34 (2006.01)
B65H 29/51 (2006.01)
B65H 31/30 (2006.01)

(52) **U.S. Cl.**

CPC ***B65H 31/34*** (2013.01); ***B65H 29/51*** (2013.01); ***B65H 31/3027*** (2013.01); *B65H 2301/4213* (2013.01); *B65H 2301/42194* (2013.01); *B65H 2401/111* (2013.01); *B65H 2404/1441* (2013.01); *B65H 2801/27* (2013.01)

(58) **Field of Classification Search**

CPC B65H 37/04
USPC 270/58.07, 58.08, 58.09, 58.11, 58.16, 270/58.17, 32, 37, 39.08
See application file for complete search history.

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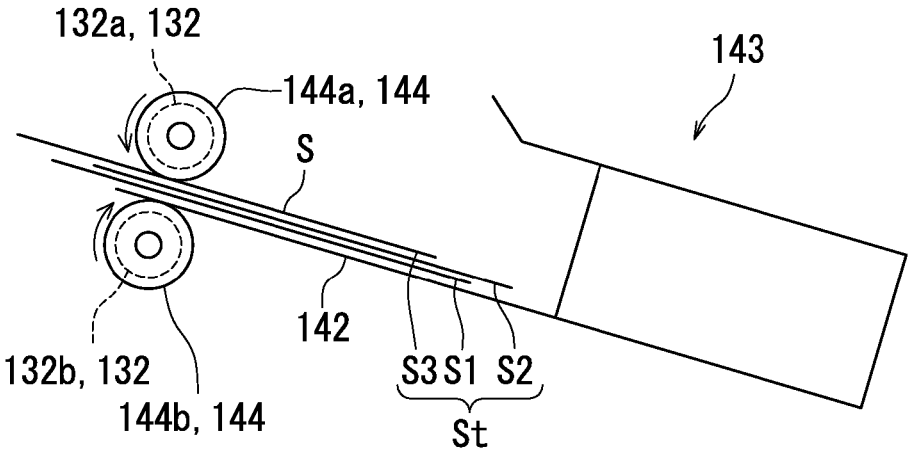
(57) **ABSTRACT**

A sheet post-processing device includes a tray, an evacuating member, a regulating member mounted on the tray, and a feed mechanism. The tray can receive sheets thereon. The evacuating member temporarily evacuates, from a conveyance path, sheets being conveyed, stacks the evacuated sheets into a pile, and conveys the pile of sheets onto the tray through the conveyance path. The feed mechanism includes a spongy elastic member and moves the pile of sheets along the tray toward the regulating member. When stacking three or more sheets into a pile, the evacuating member performs the stacking such that, in the pile conveyed to the tray, an edge of each intermediate sheet protrudes toward the regulating member beyond an edge of an uppermost sheet and an edge of a lowermost sheet.

7 Claims, 8 Drawing Sheets



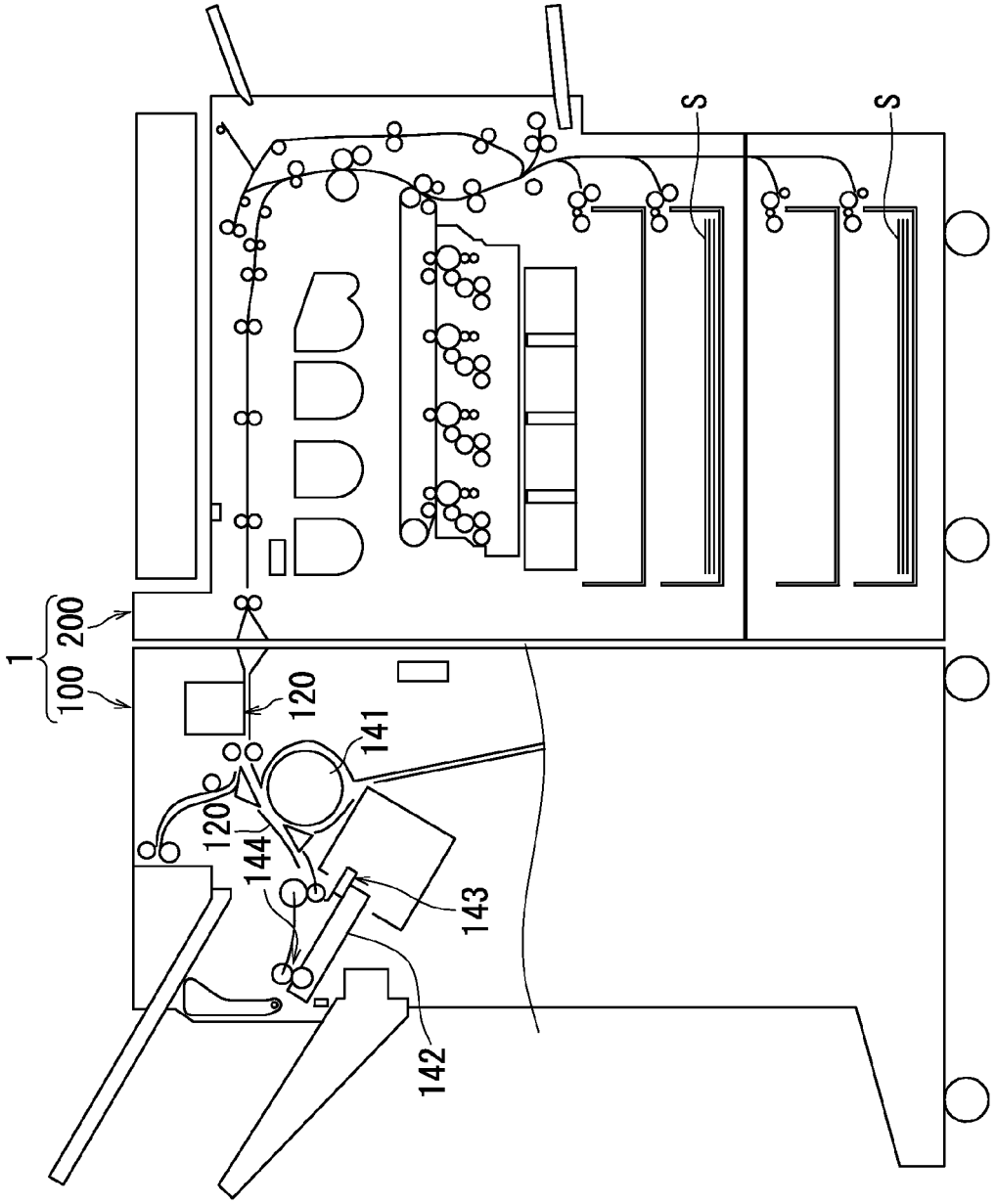


FIG. 1

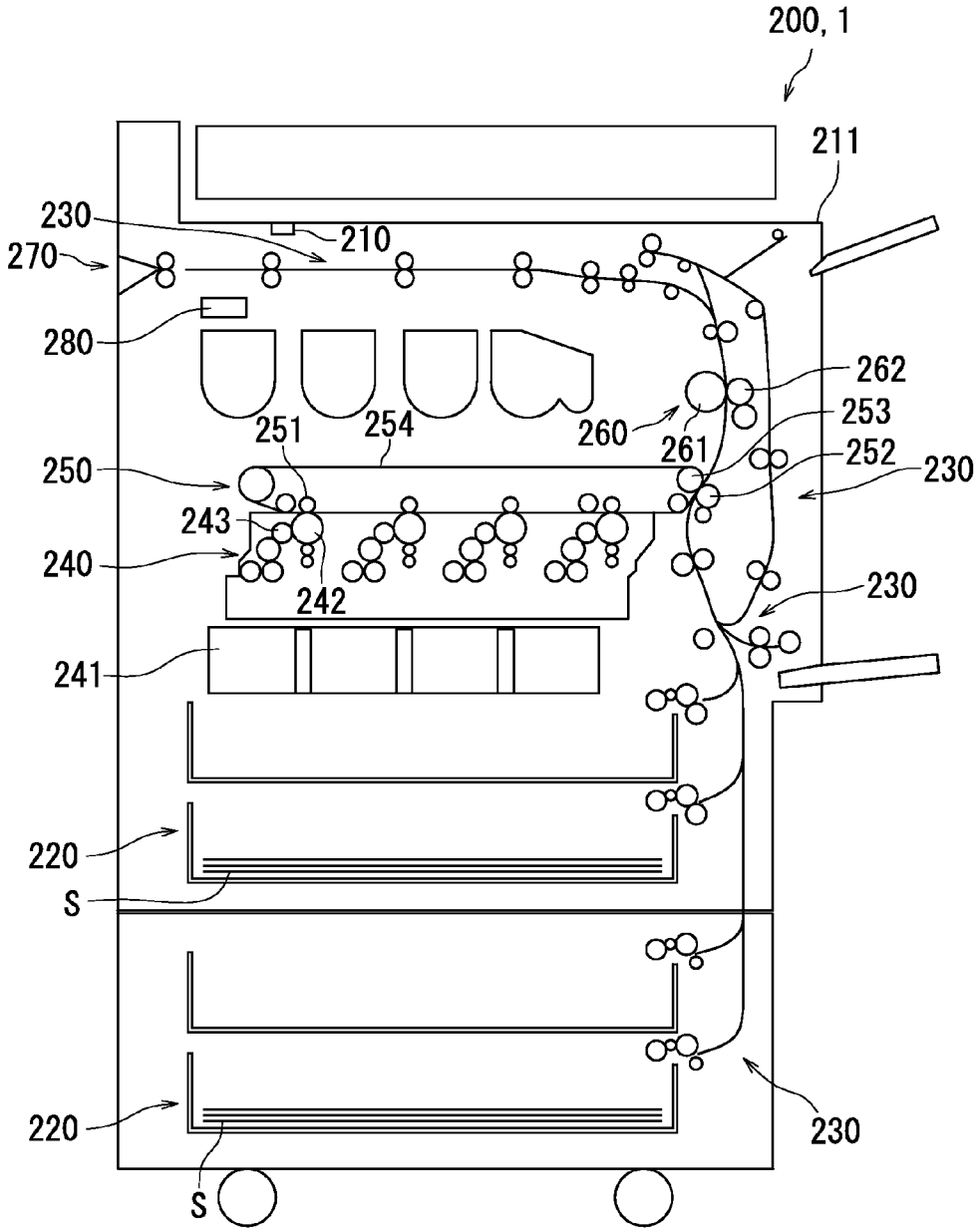

200, 1
211
230
210
270
280
262
253
251
254
260
261
252
230
250
243
240
242
230
241
220
S
220
230
S

FIG. 2

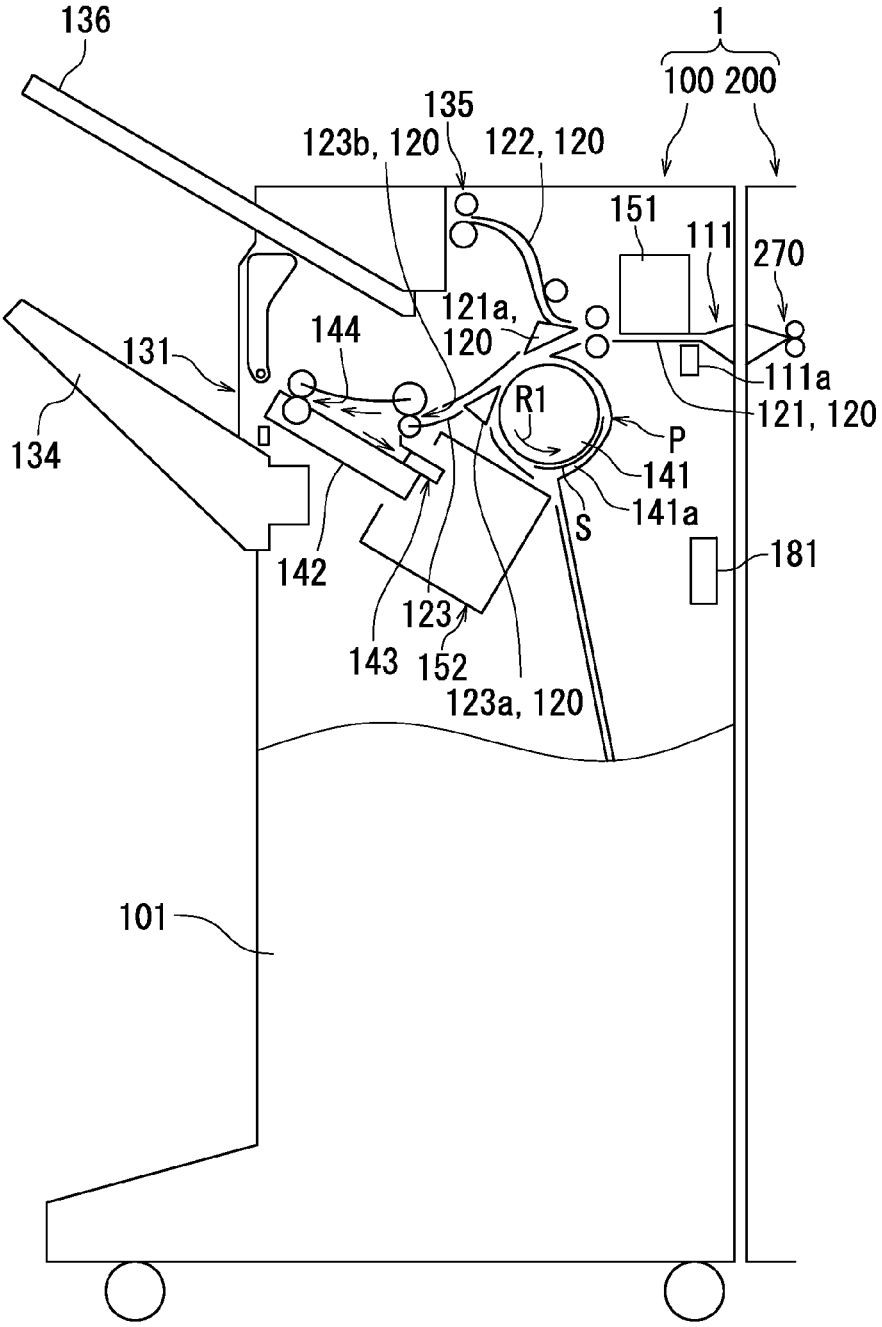

136
1
100 200
135
123b, 120
122, 120
151
111
270
121a,
120
144
131
111a
121, 120
R1
134
P
141
141a
S
181
142
123
143
152
123a, 120
101

FIG. 3

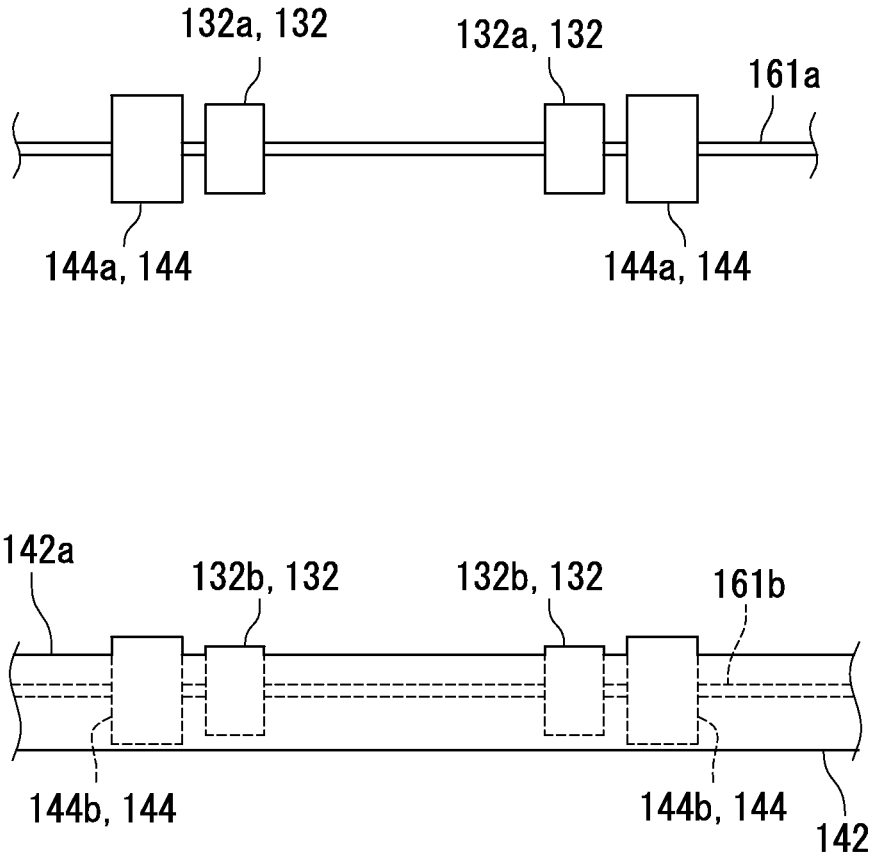

132a, 132
132a, 132
161a
144a, 144
144a, 144
142a
132b, 132
132b, 132
161b
144b, 144
144b, 144
142

FIG. 4

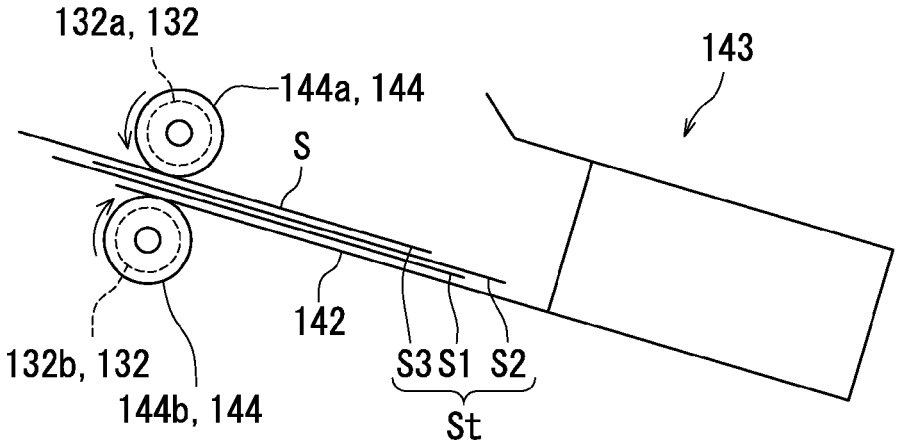

132a, 132
144a, 144
143
S
142
132b, 132
144b, 144
S3 S1 S2
St

FIG. 5A

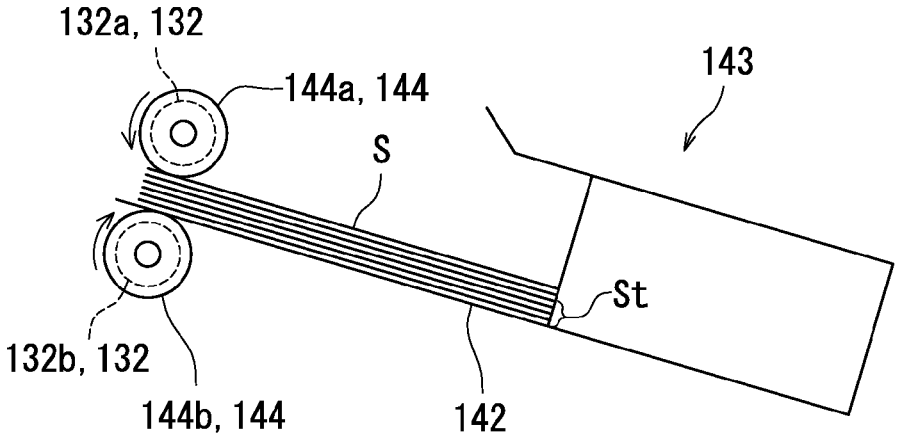

132a, 132
144a, 144
143
S
St
132b, 132
144b, 144
142

FIG. 5B

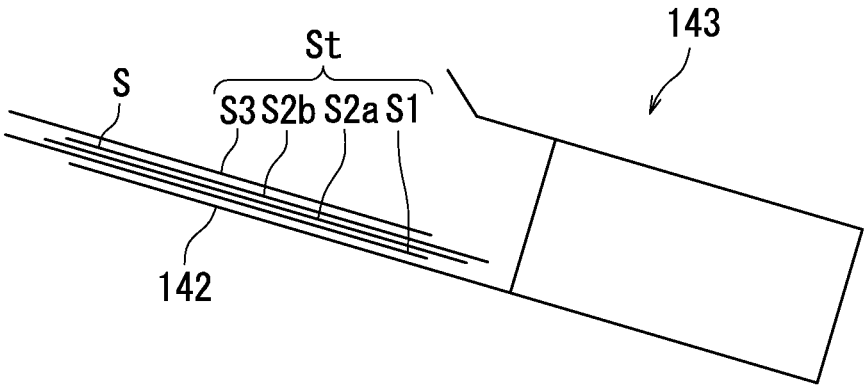


FIG. 6

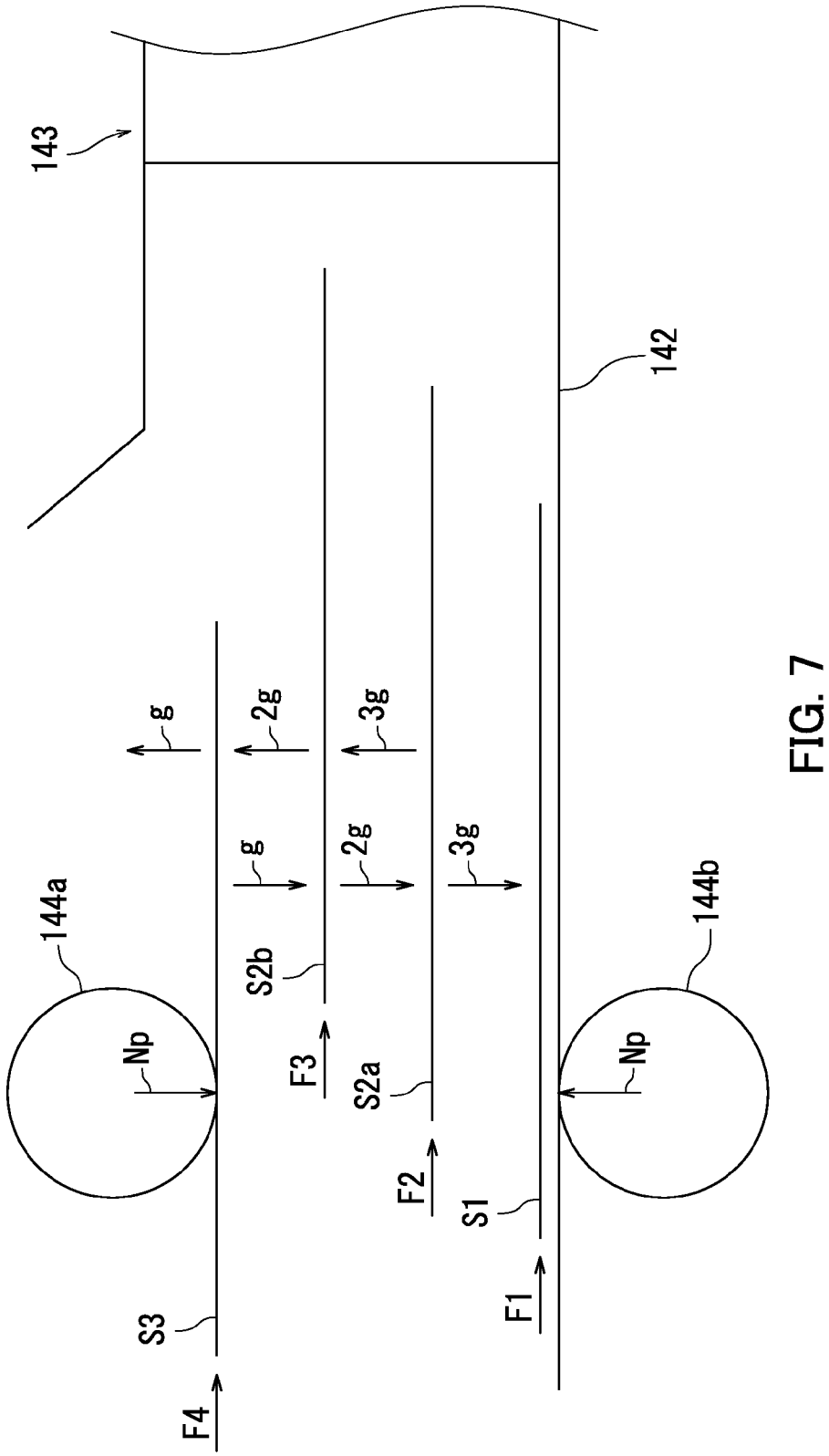


FIG. 7

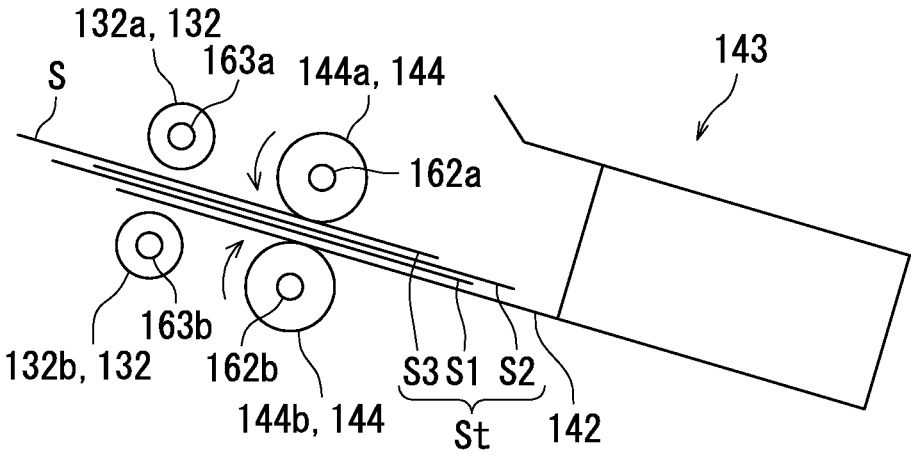

132a, 132
163a
144a, 144
143
S
162a
163b
132b, 132
162b
S3 S1 S2
144b, 144
St
142

FIG. 8A

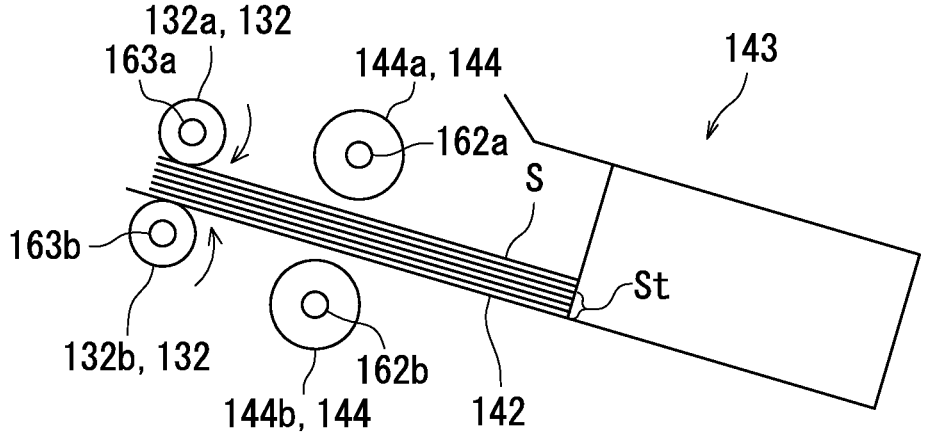

132a, 132
163a
144a, 144
143
162a
S
163b
St
132b, 132
162b
144b, 144
142

FIG. 8B

POST-PROCESSING DEVICE HAVING SHIFTED SHEETS

INCORPORATION BY REFERENCE

The present application claims priority under 35 U.S.C. §119 to Japanese Patent Application No. 2014-136730, filed Jul. 2, 2014. The contents of this application are incorporated herein by reference in their entirety.

BACKGROUND

The present disclosure relates to sheet post-processing devices and image forming apparatuses.

More and more recent image forming apparatuses such as copiers and multifunction peripherals are equipped with a sheet post-processing device, such as a finisher, for performing post-processing of sheets, such as stapling of sheets. A sheet post-processing device sequentially receives sheets having been printed by the main body of an image forming apparatus. To staple printed sheets, a conveyance section of the sheet post-processing device conveys the printed sheets to a processing tray provided within the sheet post-processing device. After conveying the sheets to the processing tray, the sheet post-processing device moves the sheets using a paddle along the processing tray toward a regulating member that is mounted on one end of the processing tray. In the manner described above, the sheets stacked on the processing tray are aligned at the edges thereof. The sheet post-processing device then staples the thus aligned sheets.

Until the sheets on the processing tray are stapled and conveyed to the exit port, subsequent sheets to be stapled cannot be conveyed to the processing tray. The sheet post-processing device is therefore provided with an evacuating member. During the time until the stapled sheets are conveyed from the processing tray to the exit port, the evacuating member evacuates, from the conveyance section, sheets sequentially fed from the image forming apparatus. The sheets evacuated by the evacuating member are stacked into a pile and held in standby. The pile of evacuated sheets is conveyed through the conveyance section onto the processing tray after the stapled sheets are conveyed from the processing tray to the exit port.

However, when three sheets are stacked into a pile, moving the pile toward the regulating member using a paddle may fail to ensure that the edges of the uppermost, lowermost, and intermediate sheets reach the regulating member. Thus, the edges of the three sheets may remain unaligned. One solution disclosed to address the problem noted above involves stacking three sheets into a pile such that, in a state where the pile is conveyed onto the processing tray and not yet moved toward the regulating member, the edge of each sheet protrudes toward the regulating member beyond the edge of an immediately lower sheet.

SUMMARY

A sheet post-processing device according to the present disclosure includes a tray, an evacuating member, a regulating member, and a feed mechanism. The tray can receive sheets thereon. The evacuating member temporarily evacuates, from a conveyance path, sheets being conveyed, stacks the evacuated sheets into a pile, and conveys the pile of sheets onto the tray through the conveyance path. The regulating member is mounted on the tray. The feed mechanism includes a spongy elastic member. The feed mechanism moves the pile of sheets along the tray toward the regulating member. When stacking three or more sheets into a pile, the evacuating member performs the stacking such that, in the pile conveyed to the tray, an edge of each intermediate sheet protrudes toward the regulating member beyond an edge of an uppermost sheet and an edge of a lowermost sheet.

An image forming apparatus according to the present disclosure includes a main body for printing an image on one or more sheets, and the sheet post-processing device described above. The main body feeds sheets requested to be fed to the sheet post-processing device from among the one or more printed sheets.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a schematic diagram of an image forming apparatus according to embodiments of the present disclosure.

FIG. **2** is a schematic diagram of a main body of the image forming apparatus according to the embodiments of the present disclosure.

FIG. **3** is a schematic diagram of major parts of the sheet post-processing device according to the embodiments of the present disclosure.

FIG. **4** is a schematic diagram of feed rollers and ejection rollers according to the embodiments of the present disclosure.

FIG. **5**A is a schematic diagram of a pile of sheets according to Embodiment 1 of the present disclosure.

FIG. **5**B is another schematic diagram of a pile of sheets according to Embodiment 1 of the present disclosure.

FIG. **6** is a schematic diagram of a pile of sheets according Embodiment 2 of the present disclosure.

FIG. **7** illustrates the forces acting on a pile of sheets according to Embodiment 2.

FIG. **8**A is a schematic diagram of feed rollers and ejection rollers according to a variation of the present disclosure.

FIG. **8**B is a schematic diagram of a different state of the feed rollers and the ejection rollers according to the variation of the present disclosure.

DETAILED DESCRIPTION

With reference to the accompanying drawings, the following describes an embodiment of a sheet post-processing device and an image forming apparatus according to the present disclosure. Throughout the drawings, the same or corresponding parts are denoted by the same reference signs, and no overlapping description is given.

Embodiment 1

FIG. **1** is a schematic diagram of an image forming apparatus according to Embodiment 1 of the present disclosure. The image forming apparatus **1** according to the present embodiment is a copier.

As shown in FIG. **1**, the image forming apparatus **1** includes a sheet post-processing device **100** and a main body **200** that is for printing an image on a sheet S. The sheet post-processing device **100** performs post-processing, such as stapling, of sheets S fed from the main body **200** after printing on the sheets S. The sheet post-processing device **100** includes a conveyance section **120**, an evacuating member **141**, a processing tray **142**, a regulating member **143**, and at least one feed roller pair **144**. In the present embodiment, a sheet S is a sheet of paper.

The conveyance section **120** sequentially conveys printed sheets S fed from the main body **200**.

The processing tray **142** can receive a plurality of sheets S thereon. The regulating member **143** is mounted on one end of the processing tray **142**. The processing tray **142** is inclined such that sheets S conveyed on the processing tray **142** slide toward the regulating member **143** under their own weight.

The evacuating member **141** is a cylindrical rotary body that is driven to rotate by a driving mechanism such as a motor. The evacuating member **141** temporarily evacuates sheets S one by one from the conveyance section **120** as the sheets S are conveyed by the conveyance section **120** toward the processing tray **142**. The evacuating member **141** can stack sheets S evacuated from the conveyance section **120** into a pile. The conveyance section **120** conveys the sheets S stacked into a pile by the evacuating member **141** onto the processing tray **142**. The feed roller pair **144** serving as a feed mechanism can move the pile of sheets along the processing tray **142** toward the regulating member **143**. Each roller in the feed roller pair **144** is a spongy elastic member.

When stacking three or more sheets S into a pile, the evacuating member **141** performs the stacking such that, once the pile is moved to the processing tray **142**, an edge of each intermediate sheet S protrudes toward the regulating member **143** beyond the edges of the uppermost and lowermost sheets S. The uppermost sheet S refers to a sheet S at the top of the pile on the processing tray **142**. The lowermost sheet S refers to a sheet S at the bottom of the pile on the processing tray **142**. An intermediate sheet S refers to a sheet S located between the uppermost sheet S and the lowermost sheet S among the three or more sheets in the pile.

Since a pile of sheets S stacked in the manner described above is conveyed to the processing tray **142**, the feed roller pair **144** can move the pile so as to ensure that an edge of each sheet S reaches the regulating member **143** even if the pile includes three or more sheets S. Consequently, the edges of the respective sheets S in the pile are aligned as detailed below.

The uppermost and lowermost sheets S in a pile receive force directly from the feed roller pair **144**. Therefore, the uppermost and lowermost sheets S are moved until their edges reach the regulating member **143**. On the other hand, intermediate sheets S do not receive force directly from the feed roller pair **144**. However, in the pile of sheets S on the processing tray **142**, the edge of each intermediate sheet S protrudes toward the regulating member **143** beyond the edges of the uppermost and lowermost sheets S. This ensures that each intermediate sheet S is moved until its edge reaches the regulating member **143**, despite the force applied by the feed roller pair **144** acting less on the intermediate sheets S than on the uppermost and lowermost sheets S. In addition, each roller in the feed roller pair **144** is a spongy elastic member. This effectively prevents the edge of an intermediate sheet S from being creased, even if the feed roller pair **144** continues to move the uppermost and lowermost sheets S after the edge of the intermediate sheet S abuts against the regulating member **143**.

The following now describes the image forming apparatus **1** according to Embodiment 1 of the present disclosure. First, the main body **200** of the image forming apparatus **1** is described with reference to FIG. **2**. FIG. **2** is a schematic diagram of the main body **200** of the image forming apparatus **1**.

The main body **200** includes a document reading section **210**, a paper feed section **220**, a conveyance section **230**, an imaging section **240**, a transfer section **250**, a fixing section **260**, an ejection section **270**, and a control section **280**.

The document reading section **210** reads an image of a document placed on a document table **211** to generate image data.

The paper feed section **220** is located at the bottom of the main body **200**. The paper feed section **220** can store a plurality of sheets S and feeds sheets S one by one to the conveyance section **230**.

The conveyance section **230** conveys a sheet S fed by the paper feed section **220** sequentially to the transfer section **250**, the fixing section **260**, and the ejection section **270**.

The imaging section **240** forms a toner image based on image data generated by the document reading section **210**. The imaging section **240** includes an exposure device **241**, a plurality of photosensitive drums **242**, and a plurality of development rollers **243**.

The exposure device **241** scans each photosensitive drum **242** with a laser beam based on the image data. Through the laser beam scanning, an electrostatic latent image is formed on the photosensitive drum **242**. Each development roller **243** supplies toner to a corresponding photosensitive drum **242** so as to develop the electrostatic latent image. As a result of the development, a toner image is formed on each photosensitive drum **242**.

The transfer section **250** includes a plurality of primary transfer rollers **251**, a secondary transfer roller **252**, a driven roller **253**, and an intermediate transfer belt **254**. The transfer section **250** transfers the toner images formed on the respective photosensitive drums **242** to the intermediate transfer belt **254** so as to overlay the toner images. The overlaid toner images are transferred from the intermediate transfer belt **254** to a sheet S.

Each primary transfer roller **251** is located opposite to a corresponding photosensitive drum **242** with the intermediate transfer belt **254** therebetween. The primary transfer rollers **251** press the intermediate transfer belt **254** against the respective photosensitive drums **242**. With this configuration, the toner images formed on the photosensitive drums **242** are transferred to be overlaid on the intermediate transfer belt **254**.

The secondary transfer roller **252** is pressed against the driven roller **253**. Consequently, a nip is formed between the secondary transfer roller **252** and the driven roller **253**. When a sheet S passes through the nip, the secondary transfer roller **252** and the driven roller **253** cause the toner image to be transferred from the intermediate transfer belt **254** to the sheet S.

The fixing section **260** includes a fixing member **261** and a pressure member **262**. The fixing section **260** applies heat and pressure to a sheet S to fix an unfixed toner image which has been transferred to the sheet S by the transfer section **250**.

The ejection section **270** ejects a sheet S having a fixed toner image to outside of the main body **200**.

The control section **280** has a storage area for storing data such as programs and setting information. The storage area is implemented by random access memory (RAM) and read only memory (ROM). The control section **280** controls the overall operation of the image forming apparatus **1** by executing different control programs stored in advance in the storage area.

With reference to FIGS. **3**, **4**, **5**A, and **5**B, the following now describes the sheet post-processing device **100** in detail. FIG. **3** is a schematic diagram of major parts of the sheet post-processing device **100**. FIG. **4** is a schematic diagram of two feed roller pairs **144** and two ejection roller pairs **132**. Sheets S ejected from the main body **200** through the ejection section **270** are sequentially fed into a housing **101** of the sheet post-processing device **100**. The sheet post-processing

device **100** performs post-processing of sheets, such as stapling, offsetting, and hole punching, on the sheets S.

As shown in FIG. **3**, the sheet post-processing device **100** includes the housing **101** roughly having a box shape, an entrance section **111**, a first ejection section **131**, a first ejection tray **134**, a second ejection section **135**, and a second ejection tray **136**. The sheet post-processing device **100** additionally includes a puncher **151**, a stapler **152**, and a controller **181**.

The entrance section **111** receives a sheet S having an image printed by the main body **200** of the image forming apparatus **1**.

The conveyance section **120** includes a first conveyance section **121**, a second conveyance section **122**, and a third conveyance section **123**.

The first conveyance section **121** extends from the entrance section **111** to a first branching member **121***a*. The first branching member **121***a* is rotatably supported. A sheet S conveyed by the first conveyance section **121** is selectively fed into the second conveyance section **122** or the third conveyance section **123** by the first branching member **121***a*.

The second conveyance section **122** extending from the first branching member **121***a* to the second ejection section **135** conveys a sheet S to the second ejection section **135**. The second ejection tray **136** receives sheets S ejected through the second ejection section **135**.

The third conveyance section **123** extends from the first branching member **121***a* to the processing tray **142**. The third conveyance section **123** includes a second branching member **123***a* and an intermediate roller pair **123***b*. A sheet S conveyed to the third conveyance section **123** is moved by the intermediate roller pair **123***b* onto the processing tray **142**. The stapler **152** performs stapling (one example of post-processing) of a plurality of sheets S on the processing tray **142**. The plurality of sheets S stapled together are ejected by the first ejection section **131** onto the first ejection tray **134**.

The evacuating member **141** rotates in a rotation direction R**1** shown in FIG. **3** in accordance with the direction of conveyance by the third conveyance section **123**. An evacuation path **141***a* is formed between the circumferential surface of the evacuating member **141** and a guide member located opposite to the circumferential surface. As the evacuating member **141** rotates in the rotation direction R**1**, the sheet S conveyed to the third conveyance section **123** wraps around the circumferential surface of the evacuating member **141**.

More specifically, to evacuate a sheet S from the third conveyance section **123**, the second branching member **123***a* is rotated to a position for forwarding sheets S into the evacuation path **141***a* as the sheet S is conveyed thereto in the third conveyance section **123**. As a result, the sheet S conveyed to the third conveyance section **123** is evacuated into the evacuation path **141***a*. The evacuation path **141***a* is provided with conveyance rollers. Each conveyance roller is located opposite to the circumferential surface of the evacuating member **141**. The sheet S fed into the evacuation path **141***a* is nipped between the evacuating member **141** and each of the conveyance rollers to be moved in the rotation direction R**1** of the evacuating member **141**. As a result, the sheet S wraps around the circumferential surface of the evacuating member **141**.

The second branching member **123***a* is rotated back to the initial position after the first ejection section **131** conveys a preceding sheet S having been subjected to post-processing from the processing tray **142** to the first ejection tray **134**. Consequently, a subsequent sheet S having been held in standby in the evacuation path **141***a* is conveyed through the third conveyance section **123** onto the processing tray **142**.

When evacuating a plurality of sheets S and holding them in standby, the evacuating member **141** stacks the plurality of sheets S into a pile. In other words, the sheets S wrap around the circumferential surface of the evacuating member **141** in layers. The pile of evacuated sheets S is conveyed to the processing tray **142** after preceding sheets S on the processing tray **142** are subjected to post-processing and moved to the first ejection tray **134**.

More specifically, during the time a plurality of sheets S on the processing tray **142** are aligned, stapled, and ejected onto the first ejection tray **134**, subsequent sheets S fed into the third conveyance section **123** are sequentially evacuated by the evacuating member **141** and stacked into a pile in the evacuation path **141***a*.

The puncher **151** is located upstream from the first branching member **121***a* in the conveyance path of sheets S. The puncher **151** performs hole punching with predetermined timing on sheets S conveyed by the first conveyance section **121**. The second conveyance section **122** is for conveying sheets S that are not to be subjected to post-processing or are only to be subjected to hole punching.

The stapler **152** staples sheets S having aligned edges with a staple. After the stapler **152** staples the sheets S, the first ejection section **131** ejects the stapled sheets S onto the first ejection tray **134**.

The controller **181** controls operation of each part of the sheet post-processing device **100** according to a request from the control section **280** of the main body **200** (see FIG. **2**).

Reference is now made to FIG. **4** to describe the feed roller pairs **144** and the ejection roller pairs **132**. The ejection roller pairs **132** are included in the first ejection section **131**. FIG. **4** is a schematic diagram of the feed roller pairs **144** and the ejection roller pairs **132** according to Embodiment 1 of the present disclosure. Note that FIG. **4** shows the processing tray **142** seen from the side of the first ejection tray **134**.

As shown in FIG. **4**, each feed roller pair **144** includes a first feed roller **144***a* and a second feed roller **144***b*. In the present embodiment, each of the rollers **144***a* and **144***b* in the respective feed roller pairs **144** is a spongy roller having a layer of elastomeric foam (an example of a spongy elastomeric member). The sheet post-processing device **100** also includes a first support shaft **161***a* and a second support shaft **161***b*. The first feed rollers **144***a* are attached to the first support shaft **161***a* and rotate in accordance with the rotation of the first support shaft **161***a*. The second feed rollers **144***b* are attached to the second support shaft **161***b*, which is embedded in the processing tray **142**, and rotate in accordance with the rotation of the second support shaft **161***b*. Each second feed roller **144***b* has a circumferential surface partially exposed above a sheet placement surface **142***a* of the processing tray **142**. Therefore, each second feed roller **144***b* abuts against a corresponding one of the first feed rollers **144***a* with a conveyed sheet S sandwiched therebetween.

Each ejection roller pair **132** includes a first ejection roller **132***a* and a second ejection roller **132***b*. In the present embodiment, each of the rollers **132***a* and **132***b* in the ejection roller pairs **132** are made of rubber and are smaller in diameter than the rollers **144***a* and **144***b* in the feed roller pairs **144**. The first ejection rollers **132***a* are attached to the first support shaft **161***a* at positions axially inward from the first feed rollers **144***a*. The first ejection rollers **132***a* rotate in accordance with the rotation of the first support shaft **161***a*. The second ejection rollers **132***b* are attached to the second support shaft **161***b* at positions axially inward from the second feed rollers **144***b*. The second ejection rollers **132***b* rotate in accordance with the rotation of the second support shaft **161***b*. Each second ejection roller **132***b* has a circumferential surface partially

exposed to protrude beyond the sheet placement surface **142***a* of the processing tray **142**. Therefore, each second ejection roller **132***b* abuts against a corresponding one of the first ejection rollers **132***a* with a conveyed sheet S sandwiched therebetween.

The first support shaft **161***a* is movable toward and away from the second support shaft **161***b*. When a pile of sheets S is conveyed from the third conveyance section **123** onto the processing tray **142**, the first support shaft **161***a* is moved to a position closer to the second support shaft **161***b*. More specifically, the first support shaft **161***a* is moved toward the second support shaft **161***b* such that the sheet pile is nipped between the first ejection roller **132***a* and the second ejection roller **132***b*. Since the first support shaft **161***a* and the second support shaft **161***b* are being rotated, the leading edge of the sheet pile is nipped by the ejection roller pairs **132** and conveyed toward the first ejection tray **134**. The rollers **144***a* and **144***b* in the feed roller pairs **144** at this time are partially compressed.

As the leading edge of the sheet pile is conveyed toward the first ejection tray **134**, the trailing edge of the sheet pile eventually drops onto the processing tray **142** from the third conveyance section **123**. When the trailing edge of the sheet pile being conveyed reaches such a position, each ejection roller pair **132** stops rotating. In one example, the third conveyance section **123** may be provided with a detection sensor in order to stop the rotation of the ejection roller pairs **132** with appropriate timing. That is, output of the detection sensor may be used to detect that the trailing edge of the sheet pile has reached a position to be dropped from the third conveyance section **123** onto the processing tray **142**. Alternatively, the controller **181** may be provided with a function of measuring a time period starting when the second branching member **123***a* is rotated back to the initial position. That is, the measured time period may be used to detect that the trailing edge of the sheet pile has reached the position to be dropped from the third conveyance section **123** onto the processing tray **142**.

Subsequently, the first support shaft **161***a* moves away from the second support shaft **161***b*. More specifically, the first support shaft **161***a* moves away from the second support shaft **161***b* to a position where the nip formed by the respective ejection roller pairs **132** is released while the feed roller pairs **144** still nip the sheet pile.

According to the present embodiment, each of the rollers **144***a* and the **144***b* in the feed roller pairs **144** is larger in diameter than each of the rollers **132***a* and **132***b* in the ejection roller pairs **132**. Therefore, as the first support shaft **161***a* moves away from the second support shaft **161***b*, the nip formed by the respective ejection roller pairs **132** is released before the nip formed by the respective feed roller pairs **144** is released. When the first support shaft **161***a* is moved away from the second support shaft **161***b* to a position where only the nip formed by the ejection roller pairs **132** is released, the first and second support shafts **161***a* and **161***b* start to rotate in reverse to the rotation direction that is for conveying a sheet pile to the first ejection tray **134**.

As a result, the sheet pile is moved toward the regulating member **143** only by the feed roller pairs **144**. For conveying sheets S from the processing tray **142** to the first ejection tray **134** after post-processing, the first support shaft **161***a* moves toward the second support shaft **161***b*. More specifically, the first support shaft **161***a* moves toward the second support shaft **161***b* to a position where the respective ejection roller pairs **132** can nip the sheets S on the processing tray **142**. Then, the first and second support shafts **161***a* and **161***b* rotate in reverse to the rotation direction for moving a sheet pile toward the regulating member **143**. As a result, the sheets S after post-processing are nipped by the respective feed roller pairs **144** as well as the ejection roller pairs **132** and conveyed to the first ejection tray **134**.

With reference to FIGS. **3**, **5**A, and **5**B, the following now describes an example in which the evacuating member **141** evacuates three sheets S. FIG. **5**A shows the state where a pile St of sheets S on the processing tray **142** is moved by the feed roller pairs **144** toward the regulating member **143**. FIG. **5**B shows the state where a plurality of (three or more) sheets S in the sheet pile St abut against the regulating member **143**.

As shown in FIGS. **3**, **5**A, and **5**B, when evacuating three sheets S, the evacuating member **141** sequentially stacks the sheets S into a sheet pile St in order of entry into the evacuation path **141***a*. Thus, the first one of the sheets S fed into the evacuation path **141***a* will be the lowermost sheet **S1**, which is located lowest in the sheet pile St on the processing tray **142**. The second one of the sheets S fed into the evacuation path **141***a* will be the intermediate sheet S, which is located between the top and the bottom in the sheet pile St on the processing tray **142**. The third one of the sheets S fed into the evacuation path **141***a* will be the uppermost sheet **S3**, which is located highest in the sheet pile St on the processing tray **142**. The evacuating member **141** stacks the sheets S into the sheet pile St such that an edge of the intermediate sheet **S2** protrudes beyond edges of the uppermost and lowermost sheets **S3** and **S1** toward the regulating member **143** in a state where the sheet pile St is on the processing tray **142**.

For example, when a sheet S, which will be the lowermost sheet **S1**, is fed into the evacuation path **141***a*, the evacuating member **141** conveys the lowermost sheet **S1** along the evacuation path **141***a*. When the leading edge (the edge at the front of the sheet S in the conveyance direction) reaches a stop position P, the evacuating member **141** stops rotating. The evacuating member **141** resumes the conveyance of the lowermost sheet **S1** a predetermined time period after a sheet-passage sensor **111***a* disposed in the entrance section **111** detects passage of a subsequent sheet S, which will be the intermediate sheet **S2**. Through the above operation, the intermediate sheet **S2** is stacked on the lowermost sheet **S1** such that one edge (the trailing edge) of the intermediate sheet **S2** protrudes beyond one edge (the trailing edge) of the lowermost sheet **S1**. A subsequent sheet S, which will be the uppermost sheet **S3**, is stacked on the intermediate sheet **S2** such that one edge (the trailing edge) of the intermediate sheet **S2** protrudes beyond the one edge (the trailing edge) of the uppermost sheet **S3**. Consequently, the three sheets S are stacked into the sheet pile St in a manner that the aforementioned one edge of the intermediate sheet **S2** protrudes toward the regulating member **143** beyond the respective edges of the uppermost sheet **S3** and the lowermost sheet **S1**.

The sheet pile St produced by the evacuating member **141** is conveyed onto the processing tray **142** through the third conveyance section **123**. Then, the sheet pile St is moved toward the regulating member **143** by the feed rollers **144***a* and **144***b* each rotating in the direction of an arrow shown in FIGS. **5**A and **5**B. As the sheet pile St is moved, the intermediate sheet **S2** abuts against the regulating member **143** first and then the lowermost and uppermost sheets **S1** and **S3** abut against the regulating member **143**. Consequently, the edges of sheets S in the sheet pile St are aligned.

When a subsequent sheet S is to be stacked on the sheet pile St that is on the processing tray **142**, the first support shaft **161***a* moves (ascends) to move the first feed rollers **144***a* away from the second feed rollers **144***b*. The subsequent sheet S then drops onto the processing tray **142** to be stacked on the sheet pile St. Then, the first support shaft **161***a* moves (de-

scends) toward the second support shaft **161***b* to cause each feed roller pair **144** to form a nip. Then, the first and second support shafts **161***a* and **161***b* rotate and thus the feed roller pairs **144** move the subsequent sheet S toward the regulating member **143**. Consequently, the edges of all the sheets S in the sheet pile St, including the subsequent sheet S, are aligned as shown in FIG. **5**B. The aligned sheets S are stapled, for example, and then ejected to the ejection tray **134** by the ejection roller pairs **132**.

As has been described with reference to FIGS. **1** to **5**A and **5**B, when evacuating three sheets S, the evacuating member **141** stacks the three sheets S into a sheet pile St such that an edge of the intermediate sheet S**2** protrudes toward the regulating member **143** in a state where the sheet pile St is on the processing tray **142**. Such stacking ensures that when the sheet pile St is moved toward the regulating member **143**, the intermediate sheet S**2** abuts against the regulating member **143** first and then the lowermost and uppermost sheets S**1** and S**2** abut against the regulating member **143**. Consequently, the edges of all the sheets S in the sheet pile St are aligned.

The rollers **144***a* and **144***b* in the feed roller pairs **144** are spongy rollers each having a layer of elastic foam. Thus, Expression 1 is satisfied when the feed roller pairs **144** move the sheet pile St toward the regulating member **143**.

Friction Force *Fa*>Sheet Creasing Force>Friction Force *Fb* Expression 1

In Expression 1, Fa denotes a friction force applied to a sheet S by each of the rollers **144***a* and **144***b* in the feed roller pairs **144**, Sheet Creasing Force denotes a force causing creasing of a sheet S, and Fb denotes a friction force arising between adjacent sheets S by the nip produced by each feed roller pair **144**.

As long as Expression 1 is satisfied, each intermediate sheet S is less likely to be creased when the uppermost and lowermost sheets S are continued to be moved toward the regulating member **143** after the edge of an intermediate sheet S abuts against the regulating member **143**. This is because the use of spongy feed rollers **144***a* and **144***b* ensures that the force applied to the intermediate sheet S**2** by each of the rollers **144***a* and **144***b* once the intermediate sheet S**2** abuts against the regulating member **143** at an edge does not exceed the stiffness of the intermediate sheet S**2** (the force required to cause creasing of the intermediate sheet S**2**). Consequently, occurrence of creasing of the intermediate sheet S**2** is reduced.

Embodiment 2

The following describes the sheet post-processing device **100** according to Embodiment 2 of the present disclosure with reference to FIGS. **3**, **6**, and **7**. In Embodiment 2, the evacuating member **141** evacuates four sheets S. The following description focuses on differences with Embodiment 1 and no overlapping description is given. FIG. **6** shows a state where a pile of four sheets S is on the processing tray **142**. FIG. **7** illustrates the forces acting on the four sheets S on the processing tray **142**.

The evacuating member **141** shown in FIG. **3** can stack four sheets S into a sheet pile St. As shown in FIG. **6**, the first one of the four sheets S fed into the evacuation path **141***a* will be a lowermost sheet S**1**, which is at the bottom of the sheet pile St on the processing tray **142**. The last one of the four sheets S fed into the evacuation path **141***a* will be an uppermost sheet S**3**, which is at the top of the sheet pile St on the processing tray **142**. The second one of the four sheets S fed into the evacuation path **141***a* will be a first intermediate sheet S**2***a*, which is on the lowermost sheet S**1**, and the third one will be a second intermediate sheet S**2***b*, which is on the first intermediate sheet S**2***a* and immediately below the uppermost sheet S**3**. The first and second intermediate sheets S**2***a* and S**2***b* are stacked such that the edge of each intermediate sheet increasingly protrudes toward the regulating member **143** in order of an increasing distance from the processing tray **142**.

Similarly to the example of stacking three sheets, when a sheet S, which will be the lowermost sheet S**1**, is fed into the evacuation path **141***a*, the evacuating member **141** conveys the lowermost sheet S**1** along the evacuation path **141***a*. When the leading edge of the lowermost sheet S**1** (the edge at the front of the sheet S in the conveyance direction) reaches the stop position P, the evacuating member **141** stops rotating. The evacuating member **141** resumes the conveyance of the lowermost sheet S**1** a predetermined time period after the sheet-passage sensor **111***a* detects passage of a subsequent sheet S, which will be the first intermediate sheet S**2***a*. Through the above operation, the first intermediate sheet S**2***a* is stacked on the lowermost sheet S**1** such that one edge (the trailing edge) of the first intermediate sheet S**2***a* protrudes beyond one edge (the trailing edge) of the lowermost sheet S**1**. A subsequent sheet S, which will be the second intermediate sheet S**2***b*, is stacked on the first intermediate sheet S**2***a* in a similar manner that one edge (the trailing edge) of the second intermediate sheet S**2***b* protrudes beyond one edge (the trailing edge) of the first intermediate sheet S**2***a*. A subsequent sheet S, which will be the uppermost sheet S**3**, is stacked on the second intermediate sheet S**2***b* such that one edge (the trailing edge) of the second intermediate sheet S**2***b* protrudes beyond one edge (the trailing edge) of the uppermost sheet S**3**. Consequently, the first and second intermediate sheets S**2***a* and S**2***b* are stacked such that the edges of the intermediate sheets protrude toward the regulating member **143** more and more in order of an increasing distance from the processing tray **142**.

According to the present embodiment, the nip pressure Np of each feed roller pair **144**, the friction coefficient μS between a sheet S and each of the feed rollers **144***a* and **144***b* in the feed roller pair **144**, the friction coefficient μP between adjacent sheets S, and the weight g of a sheet S need to satisfy Expression 2 below.

$$\mu S \times Np > \mu P \times (Np+g) \quad \text{Expression 2}$$

Therefore, the nip pressure Np of each feed roller pair **144** as well as the material of each of the feed rollers **144***a* and **144***b* is selected so as to satisfy Expression 2.

Once the respective feed roller pairs **144** starts rotating with the sheet pile St sandwiched therebetween, the forces F**4** to F**1** respectively given by Expressions 3 to 6 act on the respective sheets S in the sheet pile St as shown in FIG. **7**. More specifically, the force F**4** acts on the sheet S**3**, the force F**3** acts on the sheet S**2***b*, the force F**2** acts on the sheet S**2***a*, and the force F**1** acts on the sheet S**1**.

$$F4=\mu S \times Np+\mu P \times (Np+g) \quad \text{Expression 3}$$

$$F3=\mu P \times (Np+g)+\mu P \times (Np+2g) \quad \text{Expression 4}$$

$$F2=\mu P \times (Np+2g)+\mu P \times (Np+3g) \quad \text{Expression 5}$$

$$F1=\mu P \times (Np+3g)+\mu S \times (Np+4g) \quad \text{Expression 6}$$

In Expressions 3 to 5 above, F**1** denotes the force applied to the lowermost sheet S**1**, F**2** to the first intermediate sheet S**2***a*, F**3** to the second intermediate sheet S**2***b*, and F**4** to the uppermost sheet S**3**.

As described above, the second intermediate sheet S**2***b* protrudes toward the regulating member **143** most among all

of the sheets S in the sheet pile St. Thus, the second intermediate sheet S2*b* reaches the regulating member **143** first among the sheets S in the sheet pile St. Once the second intermediate sheet S2*b* reaches the regulating member **143**, the forces F**4**, F**2**, and F**1** respectively given by Expressions 7 to 9 are applied to the other sheets S in the sheet pile St. More specifically, the force F**4** is applied to the sheet S**3**, the force F**2** to the sheet S2*a*, and the force F**1** to sheet S**1**.

$$F4=\mu S\times Np-\mu P\times(Np+g) \quad \text{Expression 7}$$

$$F2=\mu P\times(Np+3g)-\mu P\times(Np+2g)=\mu P\times g \quad \text{Expression 8}$$

$$F1=\mu S\times(Np+4g)-\mu P\times(Np+3g) \quad \text{Expression 9}$$

Based on Expression 2 above, F**4**>0 is satisfied in Expression 7, and F**1**>0 is satisfied in Expression 9. In addition, F**2**>0 is satisfied in Expression 8. Since force F continues to act on the sheets S**3**, S2*a*, and S**1** in the sheet pile St in a direction toward the regulating member **143**, the sheets S**3**, S2*a*, and S**1** continue to move toward the regulating member **143**.

Once the first intermediate sheet S2*a* has reached the regulating member **143**, the forces F**4** and F**1**, which are respectively equal to the forces F**4** and F**1** given by Expressions 7 and 9 above, are applied to the other sheets S**3** and S**1**. Since the force F continues to act on the sheets S**3** and S**1** in a direction toward the regulating member **143**, the sheets S**3** and S**1** continue to move toward the regulating member **143**.

As a result, the edges of the four sheets S (S**1**, S2*a*, S2*b*, and S**3**) included in the sheet pile St all abut against the regulating member **143** and thus align.

The present embodiment is described through an example in which four sheets S are evacuated. However, the number of sheets to be evacuated is not limited to four and may be five or more.

The above has described the embodiments of the present disclosure with reference to the accompanying drawings (FIGS. **1** to **7**). However, the present disclosure is not limited to the embodiments described above and may be practiced through different variations without departing from the essence of the present disclosure.

For example, according to the embodiments described above, the first feed rollers **144***a* are coaxial with the first ejection rollers **132***a*, whereas the second feed rollers **144***b* are coaxial with the second ejection rollers **132***b*. However, the present disclosure is not limited to this configuration. For example, as shown in FIGS. **8**A and **8**B, the first feed rollers **144***a* and the first ejection rollers **132***a* may have mutually different axes, and the second feed rollers **144***b* and the second ejection rollers **132***b* may have mutually different axes. More specifically, the first feed rollers **144***a* are attached to a third support shaft **162***a*, and the second feed rollers **144***b* are attached to a fourth support shaft **162***b*. The first ejection rollers **132***a* are attached to a fifth support shaft **163***a*, and the second ejection rollers **132***b* are attached to a sixth support shaft **163***b*. The third support shaft **162***a* is movable toward and away from the fourth support shaft **162***b*. Similarly, the fifth support shaft **163***a* is movable toward and away from the sixth support shaft **163***b*. The third and fourth support shafts **162***a* and **162***b* are located toward the regulating member **143** relative to the fifth and sixth support shafts **163***a* and **163***b*. That is, the feed roller pairs **144** are located closer to the regulating member **143** than the ejection roller pairs **132** are to the regulating member **143**. The feed first rollers **144***a* may be attached at positions axially inward or outward from the first ejection rollers **132***a*, whereas the second feed rollers **144***b* may be attached at positions axially inward or outward from the second ejection rollers **132***b*.

The feed roller pairs **144** and the ejection roller pairs **132** operate in the same manner as in Embodiment 1. In short, as shown in FIG. **8**A, to forward a sheet pile St to the regulating member **143**, the fifth support shaft **163***a* moves away from the sixth support shaft **163***b* and the third support shaft **162***a* moves toward the fourth support shaft **162***b*. More specifically, the third to sixth support shafts **162***a*, **162***b*, **163***a*, and **163***b* are moved to positions such that the sheet pile St is nipped only between each first feed roller **144***a* and the corresponding second feed roller **144***b*. Then, through rotation of the feed roller pairs **144**, the sheet pile St is moved toward the regulating member **143**. In short, the sheet pile St is moved only by the feed roller pairs **144** in the direction toward the regulating member **143**. As has been described above, each of the feed rollers **144***a* and **144***b* has a layer of elastomeric foam. This reduces occurrence of creasing of the sheets S.

When the sheet pile St is conveyed toward the first ejection tray **134**, the third support shaft **162***a* moves away from the fourth support shaft **162***b* and the fifth support shaft **163***a* moves toward the support shaft **163***b*, as shown in FIG. **8**B. More specifically, the third to sixth support shafts **162***a*, **162***b*, **163***a*, and **163***b* are moved to the positions such that the sheet pile St is nipped only between each first ejection roller **132***a* and the corresponding second ejection rollers **132***b*. Through the rotation of the ejection roller pairs **132**, the sheet pile St is conveyed toward the first ejection tray **134**.

According to the embodiments described above, each of the feed rollers **144***a* and **144***b* has a layer of elastomeric foam. However, this is only an example and the feed rollers **144***a* and **144***b* are not limited to such a configuration. For example, the feed rollers **144***a* and **144***b* may be any rollers that are more pliable than the ejection rollers **132***a* and **132***b* made of rubber, and that have a lower friction coefficient with a sheet S than that of the rubber-made ejection rollers **132***a* and **133***b* with a sheet S.

According to the embodiments described above, the sheet post-processing device includes two feed roller pairs **144**. However, the present disclosure is not limited to such a configuration. For example, the sheet post-processing device may include one feed roller pair **144** or three or more feed roller pairs **144**.

Additionally, according to the embodiments described above, the sheet post-processing device includes the two feed roller pairs **144**. However, the present disclosure is not limited to such a configuration. For example, a single roller may be used as the feed mechanism.

Additionally, according to the embodiments described above, the sheet post-processing device includes two ejection roller pairs **132**. However, the present disclosure is not limited to such a configuration. For example, the sheet post-processing device may include one ejection roller pair **132** or three or more ejection roller pairs **132**.

Additionally, according to the embodiments described above, the sheet post-processing device includes two ejection roller pairs **132** for ejection of sheet S onto the first ejection tray **134**. However, the present disclosure is not limited to such a configuration. For example, the sheet post-processing device may include a single roller for ejection of sheet S onto the first ejection tray **134**.

In the embodiments, the feed roller pairs **144** are described as an example of the feed mechanism. However, the present disclosure is not limited such. For example, the feed mechanism may be a caterpillar mechanism having a spongy elastic member.

According to the embodiments described above, the feed roller pairs **144** are used alone to move a sheet pile St or a sheet S toward the regulating member **143**. However, the present disclosure is not limited to such. For example, a paddle may be used in addition to the feed roller pairs **144**. In this variation, the sheet pile St is preferably stacked such that an edge of the lowermost sheet S**1** protrudes toward the regulating member **143** beyond the edge of the uppermost sheet S**3** (see FIG. **5**). Stacking sheets S into a sheet pile St in this manner ensures that the lowermost sheet S**1** reaches the regulating member **143** before the uppermost sheet S**3**. After the lowermost sheet S**1** reaches the regulating member **143**, the paddle is used to move the uppermost sheet S**3** toward the regulating member **143**. Through the above operation, the edges of all of sheets S in the sheet pile St can reach the regulating member **143** and the edges of the sheets S in the sheet pile St are aligned. When a subsequently fed sheet S is further stacked on the sheet pile St, the paddle may be used to move the subsequent sheet S toward the regulating member **143** after the uppermost sheet S**3** reaches the regulating member **143**. This ensures that that the edge of the subsequent sheet S reaches the regulating member **143** and the edge of the subsequent sheet S is aligned with the edge of the sheet pile St.

In the embodiments described above, all sheets S printed by and ejected out of an image forming apparatus are fed to the sheet post-processing device **100**. However, the present disclosure may be used with an image forming apparatus that selectively feeds sheets S on which post-processing is requested to be performed. In this case, the main body of the image forming apparatus selectively feeds requested sheets S to the sheet post-processing device **100** out of sheets S having been printed.

In the embodiments described above, sheets of paper are used as sheets S. However, other types of sheets S such as resin sheets may be used as sheets S.

Note that the accompanying drawings schematically show the components described above. Thus, the dimensions such as thicknesses and lengths may differ from actual ones for the convenience of preparing the drawings.

What is claimed is:

1. A sheet post-processing device that performs post-processing on printed sheets, the sheet post-processing device comprising:

a tray configured to receive sheets thereon,

an evacuating member configured to:

temporarily evacuate, from a conveyance path to an evacuation path, sheets being conveyed,

stack the evacuated sheets into a pile, and

convey the pile of sheets onto the tray through the conveyance path;

a regulating member mounted on the tray;

a feed mechanism that includes a spongy elastic member and configured to move the pile of sheets along the tray toward the regulating member; and

a control section configured to cause the evacuating member to performs stacking of three or more sheets into a pile of sheet, wherein

the pile of the three or more sheets includes an uppermost sheet located on top of the pile, a lowermost sheet located in lowest in the pile, and an intermediate sheet located between the uppermost sheet and the lowermost sheet,

the control section causes the evacuating member to:

convey the lowermost sheet along the evacuating path when a sheet that is to be the lowermost sheet is conveyed into the evacuation path,

stop rotating when a leading edge of the lowermost sheet reaches a stop position P in the evacuation path,

resume conveyance of the lowermost sheet after a predetermined time period elapses, and stacks the intermediate sheet on the lowermost sheet such that a trailing edge of the intermediate sheet protrudes beyond a trailing edge of the lowermost sheet, and

stack a subsequent sheet that is to be the uppermost sheet on the intermediate sheet such that the trailing edge of the intermediate sheet protrudes beyond a trailing edge of the uppermost sheet, the trailing edge of the intermediate sheet protruding toward the regulating member beyond the trailing edge of the uppermost sheet and the trailing edge of the lowermost sheet in the pile conveyed to the tray,

the sheet post-processing device further comprising:

an ejection tray; and

an ejection roller pair configured to nip the pile conveyed from the evacuating member and convey the pile toward the ejection tray, wherein

the feed mechanism includes a feed roller pair configured to nip the pile on the tray and convey the pile to the regulating member,

each roller in the feed roller pair is a spongy elastic member,

in conveyance of the pile conveyed from the evacuating member onto the tray, the ejection roller pair nips the pile conveyed from the evacuating member and conveys the pile toward the ejection tray, and stops rotating to release nipping when a trailing edge of the pile reaches a position to be dropped onto the tray,

the feed roller pair nips the pile,

the feed roller pair still nips the pile when the ejection roller pair releases nipping, and

after the ejection roller pair releases the nip, the feed roller pair rotates in an opposite direction to a direction that is for conveying the pile to the ejection tray to move the pile toward the restricting member.

2. The sheet post-processing device according to claim **1**, wherein

one of each roller in the feed roller pair is coaxial with one of each roller in the ejection roller pair, and

the other of each roller in the feed roller pair is coaxial with the other of each roller in the ejection roller pair.

3. The sheet post-processing device according to claim **2**, wherein

the one of each roller in the feed roller pair is larger in diameter than the one of each roller of the ejection roller pair, and

the other of each roller in the feed roller pair is larger in diameter than the other of each roller of the ejection roller pair.

4. The sheet post-processing device according to claim **1**, wherein

the feed mechanism is located closer to the regulating member than the ejection roller pair is.

5. The sheet post-processing device according to claim **1**, wherein

the evacuating member performs the stacking such that, in the pile conveyed to the tray, an edge of the lowermost sheet protrudes toward the regulating member beyond an edge of the uppermost sheet.

6. The sheet post-processing device according to claim **1**, wherein

the intermediate sheet of the pile includes a plurality of intermediate sheets between the uppermost sheet and the lowermost sheet, and

edges of the intermediate sheets increasingly protrude toward the regulating member in order of an increasing distance from the tray.

7. An image forming apparatus comprising:

a main body for printing an image on one or more sheets, and

the sheet post-processing device according to claim **1**, wherein

the main body feeds sheets requested to be fed to the sheet post-processing device from among the one or more printed sheets.

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